JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 19 FEBRUARY 4, 1929 No. 3

GEOLOGY.—*Middle Devonian pelecypods of Wisconsin and their bearing on correlation.*[1] ERWIN R. POHL, Vanderbilt University.
(Communicated by R. S. BASSLER.)

INTRODUCTION

It has been the pleasure and privilege of the writer for the past three years to engage in a coöperative effort, under the auspices of the United States National Museum and the Milwaukee Public Museum, to understand more fully the fauna of the Wisconsin Devonian formations and the relationship of these formations to those of other areas. A small, roughly semicircular patch in south-eastern Wisconsin preserves Middle Devonian rocks and a lone outlier near the Keweenaw on Lake Superior, Limestone Mountain, has yielded fossils of Helderbergian type. The latter are few, however, and their isolated presence in the north can shed no direct light on the connections of the Middle Devonian beds. The only significant fact to be learned from them is that of marine deposition on the flanks of the old Laurentian positive area.

The discovery of Middle Devonian types of fossils long ago established in a general sense the age of the Milwaukee and Ozaukee County deposits, but the literature shows a progressive tendency on the part of paleontologists to recognize the impropriety of unreserved identifications of the Milwaukee species with those described from New York, Ohio, Michigan, and Iowa. This tendency has brought into question the hypothetical narrow strait assumed to occupy in Mid-Devonian time a position within the present boundaries of Wisconsin and Michigan and to allow either complete or limited communication

[1] Received January 3, 1929. Read before the Paleontological Society, December 27, 1928.

between enormous contemporaneous eastern and western arms of the sea. It has recently been shown that the formations to the west in Iowa, to whose described forms many Wisconsin species were compared, belong not to the Middle but to the Upper Devonian—a fact in itself sufficient to put to rest the assumption of contemporaneity of the New York, Wisconsin, and Iowa species. Finally, from evidence afforded by a close study of the pelecypod fauna of the Milwaukee beds comes the conviction that there has been no commingling of faunas or species from the east and west.

As early as 1882 Whitfield, in describing several new species from the Milwaukee formation, pointed to differences in many others. In 1899 Teller and Monroe, amateur collectors but nevertheless close students, recognized enough difference in many fossils to compare them with nearly related described forms rather than to identify them unreservedly. H. F. Cleland described 35 new and well founded species and pointed to striking dissimilarities from described forms in as many more species although allowing them to remain within the scope of those forms. John M. Clarke, than whom in the past generation none had better knowledge of the New York Devonian, in personal correspondence with Cleland frequently placed his sanction on an identification of a Wisconsin species with one from New York only with the reservation that a question mark be annexed. The Echinodermata, as studied by Weller, Springer, and Cleland, show the distinction particularly well, for they belong almost without exception to completely differentiated and easily distinguished new types. The pelecypod association is unique, not a single instance having been found of unquestionable identification with forms elsewhere described.

Wisconsin Devonian Pelecypods

The Devonian section of eastern Wisconsin comprises three phases, separated from each other at present primarily on the evidence of the contained faunas rather than upon stratigraphy. Table 1 gives complete lists of the various pelecypod associations, and it need be remarked here only that specific distinctions are sharp between the lamellibranchs of the three formations.

In the Ozaukee and Thiensville beds (manuscript names used by G. O. Raasch for the lowermost phase of the Wisconsin Devonian), the preservation of the pelecypods is inadequate for more than generic comparison. The genera, among them *Conocardium*, *Schizodus*, *Janeia*, *Sphenotus*, *Leiopteria* and *Leptodesma*, are well-advanced

Devonian types and it is a little surprising to discover them at the base of the Devonian column in Wisconsin. The association would suggest a derivation similar to that of part of the lower Cedar Valley of Iowa.

The Lake Church formation (manuscript name of G. O. Raasch), the stratigraphic position of which is still in question, has yielded a small, but unique assemblage of fossil pelecypods. The derivation of the materials and of the fauna is not known. It is difficult to believe that an association of species so remarkably differentiated should have developed indigenously in as short a time and under as normal a condition as is indicated by the less than 20 feet of pure, dolomitic limestone to which, so far as known, they are confined. The presence of generic types known to have a northern origin such as *Ilionia*, *Conocardium* (*altum* and *brevialatum* groups), *Paracyclas* (*"elliptica"* group), *Schizodus* (*appressus* group), and *Lophonychia*, leads to the supposition of north-eastern if not Arctic connections for this fauna.

The Milwaukee formation contains a very abundant pelecypod fauna—43 species in 19 genera. The relationships of this fauna are with the North-Atlantic Hamilton fauna, whose typical development is in eastern New York (Table 2).

Middle Devonian of the Central Basin

Throughout extended stratigraphic work in the Middle Devonian of the Central Basin an understanding of the interrelations of the formations and their contained faunas has been the chief objective. The predominantly Hamilton aspect of the Milwaukee fauna has already been noted, and in searching for the path of its incursion we are immediately struck by its faunal isolation. In the remarkably complete development of Erian deposits in the adjacent south and east we look in vain for faunal connections. The contemporary invasions into the states on the south—Missouri, Illinois, Kentucky, Indiana, and southern Ohio—brought in generic types known to have a southern derivation and totally unlike the Milwaukee forms.

Of other comparable sections we have only the profusely fossiliferous Michigan series. It is natural to look toward these nearest Middle Devonian deposits for illumination, but here a hitherto entirely unsuspected problem arises. Only the salient features of the Michigan section and the exact stratigraphic position it holds will be noted here, for the detailed sections and evidence for the assignments made are the subjects of present studies by the author. The Silica shale of northwest-

TABLE 1.—STRATIGRAPHIC DISTRIBUTION OF SPECIES

A. MILWAUKEE FORMATION

	Zones.		
	A.	B.	C.
Grammysia ulrichi Pohl	....	×	....
G. marginata Pohl	....	×	....
G. regularis Pohl	....	×	....
Cimitaria obtusiloba (Cleland)	....	×	....
Edmondia fragilis Cleland	....	×	....
Nucula triangula Pohl	....	×	....
Nuculites laphami Cleland	....	....	×
Palaeoneilo milwaukeensis (Cleland)	....	....	×
P. sp. cf. *constricta* (Conrad)	....	×	....
P. pulchella Pohl	....	?	×
P. deveza Pohl	....	×	....
P. corrugata Pohl	?	×	....
P. corrugata angulata Pohl	×	....	....
P. persinuata Pohl	....	....	×
P. dentata Pohl	....	....	×
Nuculana gibbosa Pohl	....	....	×
Megambonia wisconsinensis Cleland	×	....	....
Leiopteria acutilaris Pohl	....	....	×
Actinopteria rhombolineare Pohl	....	....	×
A. pauciradiata Pohl	×	....	....
A. singularis Pohl	....	....	×
A. sp.	....	×	....
Mytilarca cingulosa Pohl	....	×	....
M. dentata Pohl	....	×	....
Plethomytilus suberectus Pohl	....	×	....
Lophonychia cultellata Pohl	....	×	....
Conocardium ornatum Cleland	....	....	×
Aviculopecten bassleri Pohl	....	....	×
A. hystriculus Pohl	....	....	×
A. duplicostatus Pohl	×	....	....
A. sp.	....	....	×
Vertumnia telleri Cleland	....	×	....
V. simplex Pohl	....	....	×
V. barretti Pohl	....	....	×
V. intercalaris Pohl	....	....	×
V. edwardsi Pohl	....	....	×
V. raaschi Pohl	....	×	....
Schizodus dubius Pohl	....	×	....
Modiomorpha saccula Pohl	....	×	....
M. elongata (Cleland)	....	×	....
M. pediformis Pohl	....	×	....
M. obliqua Cleland	×	....	....
M. mytiloides milwaukeensis Pohl	....	×	....
M. schucherti Cleland	....	×	....
Paracyclas paradoxica Pohl	....	....	×
P. sp.	....	×	×

B. Lake Church Formation

?Pterinea paucicostata Cleland
Actinopteria conveza Pohl
Lophonychia trigonale (Cleland)
Conocardium truncatum Pohl
C. auritum Pohl
C. intersculptum Pohl
Schizodus acutangulus Pohl
Paracyclas obesa-umbonata Pohl
P. elliptica milwaukeensis Pohl (?)
Ilionia tenuistriata (Cleland)

C. Ozaukee and Thiensville Beds

Conocardium sp.
Schizodus sp.
Jancia cf. *vetusta* Meek
Sphenotus cf. *contractus* (Hall)
S. sp.
Leiopteria sp.
Leptodesma sp.

TABLE 2.—Taxonomic Affiliation of the Pelecypods of the Milwaukee Formation

Wisconsin	New York (Lower Hamilton)
Grammysia ulrichi Pohl	*G. nodocostata* Hall
G. marginata Pohl	*G. nodocostata* Hall
G. regularis Pohl	*G. arcuata* (Conrad) *G. subarcuata* Hall
Cimitaria obtusiloba (Cleland)	*C. recurva* (Conrad) *C. corrugata* (Conrad)
Palaeoneilo sp. cf. *constricta* (Conrad)	*P. constricta* (Conrad)
P. dentata Pohl	*P. constricta* (Conrad)
P. corrugata Pohl	*P. emarginata* (Conrad)
P. corrugata angulata Pohl	*P. emarginata* (Conrad)
P. pulchella Pohl	*P. fecunda* Hall
P. deveza Pohl	*P. maxima* (Conrad)
Nuculana gibbosa Pohl	*N. rostellata* (Conrad)
Megambonia wisconsinensis (Cleland)	*M. cardiiformis* Hall
Leiopteria acutilaris Pohl	*L. conradi* Hall
Plethomytilus suberectus Pohl	*P. oviformis* (Conrad)
Conocardium ornatum Cleland	*C. cuneus* (Conrad)
Actinopteria rhombolinearis Pohl	*A. boydi* (Conrad) *A. quadrula* (Conrad)
Vertumnia barretti Pohl	*V. reversa* Hall
V. simplex Pohl	*V. avis* Hall
Modiomorpha saccula Pohl	*M. concentrica* (Conrad)
M. elongata (Cleland)	*M. concentrica* (Conrad)
M. pediformis Pohl	*M. mytiloides* Hall
M. mytiloides milwaukeensis Pohl	*M. mytiloides* Hall

ern Ohio is nothing more than the exact equivalent of the Bell shale at the base of the Michigan Traverse. At Silica the Bell shale rests disconformably on the Columbus limestone (of true Onondaga affinities). Thus the lower boundary of the Traverse is definitely established. Three oscillatory phases of the Traverse are developed on the two sides of the state, in the northern part of the southern peninsula, to a maximum thickness exceeding 500 feet. The Thunder Bay phase, or uppermost division in eastern Michigan, carries a peculiar and profuse assemblage of species which are also to be found in the lowest exposed beds across Lake Huron in Ontario. The top of the beds in Ontario, the so-called Olentangy shale, is separated by overlap from the succeeding "Widder beds," which in turn are directly correlatable with the middle of the Hamilton section at East Bethany, in central New York. Upper and lower limits are thus clearly defined for the Michigan Traverse, no part of which is correlatable with the true Hamilton of eastern New York. The Marcellus deposits may be in part a time-equivalent of the Traverse, but stratigraphic evidence indicates a minimum of 500 feet of interruped limestone deposition in the east-central Basin between the Onondaga and the Hamilton. In view of the stratigraphic position occupied by the Traverse, despite the fact that it also is of northern invasion, it is not unexpected that we find no relation of faunas nearer than generic similarity between the Milwaukee and the Michigan beds.

The upper Devonian age of the Iowa formations has already been noted, and by the process of elimination we are left with only inferential faunal and stratigraphic evidence of the derivation of the Wisconsin Devonian.

Conclusion

The northern complexion of the Milwaukee fauna, the complete lack of stratigraphic equivalents in surrounding regions, the isolation of the area, the singularity of specific types, and their close although easily distinguishable relation to the north-Atlantic Hamilton, has thus far been summarily reviewed. Alternative paths of seaway encroachment now suggest themselves. Considering the possibility of approach by way of the South Laurentian-St. Lawrence trough, no indications of ingress by that route are afforded. Contrarily, the possibility is denied by the present absence of Devonian beds and the resulting necessity for complete removal of all Devonian beds from this area subsequent to deposition. Thus we arrive at the assumption

that the invasion encroached from the north by means of connection with James Bay around the north of the Laurentian positive area.

The unique assemblage in the limited area in eastern Wisconsin can not be considered an indigenous fauna because of its close connection with that confined to the Hamilton (Skaneateles) of eastern New York. The specific distinction is rather to be explained on the basis of non-contemporaneity, since both faunas were derived from the same mother oceanic association. Absence of several types or the presence of new ones in either of the areas is incidental and due to the changing character of the associations in the permanent basins and the ecologically varying conditions in the two regions. Stratigraphic and faunal inferences necessitate an extremely late Erian time equivalency for the Milwaukee formation, and it is probable that all of the Devonian in the eastern part of Wisconsin is later in deposition than any portion of the typical Hamilton.

PALEONTOLOGY.—*The status of the classification of the trilobites.*[1] E. O. ULRICH, U. S. Geological Survey.

The classification of the trilobites in both modern and older textbooks suggests that they fall as readily into line as though made to order. The genera and families seem sharply defined, and the descriptions seldom indicate any doubt regarding the soundness of the arrangement. However, the critical student who seeks to prove the indicated relationships for himself soon notes discrepancies and incongruities that grow and multiply till his confidence is weakened and finally almost destroyed. Such at least has been my experience during the twenty years or so that I have devoted mainly to the study of one after another of the genera and families of trilobites. The results of these studies, usually at variance with the views of the authorities, are only now being completed to the point where I might consider myself warranted in publishing them. But they were extensively employed and have always been available as paleontological criteria in the stratigraphic investigations that primarily occasioned the study of the fossils.

Prevailing conceptions regarding the systematic relations of the Ordovician and older trilobites are too largely based on overworked theories, weakly grounded deductions, and pure assumptions employed indiscriminately as though they were established facts and immutable

[1] Received January 3, 1929. Published by permission of the Director of the U. S. Geological Survey.

laws. In other words, quoting from a recent reviewer,[2] "The determination of the significance of structural conditions is based less on what may be or has been observed than on biologic theories." Though fully convinced that most of our theories of evolution are essentially true and properly applicable in certain cases, it yet seems to me they have been so burdened by unreserved and too often quite unwarranted applications that the confidence really due them has been seriously impaired. No laws of evolution have yet been discovered which, in the present state of knowledge, may be applied without reservation and severe limitation. Usually the actual genetic relations of extinct organisms, on the one hand, and the general trend of their evolutional modification, on the other, are only very obscurely indicated in the tangled and interwoven skein of life-processes that nature has preserved in accessible fossiliferous rocks. And so the paleontologist must do his part in working out the by no means simple methods through which the present stages in the ever changing expression of life history were achieved.

A moment's thought suffices to convince the worker that the available fossil remains are but occasional small bits of ramifying threads whose distal ends can only rarely be ascertained and whose proximal ends or roots are most difficult to recognize in the maze of heredity. Characters that are generally developed in the early stages of a particular line and subsequently lost, may be temporarily revived and without apparent warning in almost any of its later stages or off-shoots. In other cases the general trend of the evolution of certain parts is suddenly reversed. Such apparent anomalies not only result in mistaken conclusions regarding the age of the fossils, but they also inject unwelcome doubt as to the verity of previously fixed conceptions which seemed to work satisfactorily enough so long as the field of work was limited and disturbing factors were few enough to be neglected. Fossils were loosely identified, and the idea of local variations of species covered a multitude of stratigraphic sins. Now, however, since other ideas have crept into stratigraphy and our field of investigations has been extended to Paleozoic basins wholly unknown or barely touched before, the disturbing factors have become so numerous that they can no longer be ignored.

One of the striking collateral results of this expansion is the fact that more new things are in hand and awaiting publication than at any

[2] RUDOLF RICHTER. Reviews in Neues Jahrb. Min. Geol. Pal., Jahrg. 1922, Bd. 2, Heft 3, 1923.

preceding time since we began to study fossils. But it should not be supposed that all or even most of these additions come from the recently discovered basins. On the contrary, by far the greater number have resulted from the more intensive and more securely founded restudy of fossil faunas and old collections that had been reported on long ago. As the sequence and field relations of geological formations became better understood, and the fact of frequent and varying oscillation of continental seas was established, the need of more intensive study of their fossil contents and the closer discrimination of species and varieties that would or might be of exact value in recognizing and correlating the particular stratigraphic horizons in which they occur became correspondingly pressing. The biological by-product of these more detailed studies is a steadily accumulating mass of data that bears directly on evolution in general and the genetic relations of fossil species and genera in particular. All of the various theories of evolution that still have adherents among zoölogists can find support in this mass of evidence. A master mind is needed to weave the scattered threads into a comprehensive scheme of organic evolution.

However, when it comes to the genetic relations of fossil species and genera the problems can be successfully attacked only by the specialists in stratigraphic paleontology. They have the required detailed knowledge of the concerned organic remains, and they alone have the exceedingly important stratigraphic information that enables them to check their knowledge of the things themselves with the chronologic aspects of each case. The latter factors, particularly as they concern the stratigraphic and paleogeographic ranges of the several specific and generic types, I deem absolutely essential before final conclusions are warranted.

Four conditions are mainly responsible for the many present doubts regarding the genetic and systematic relations of trilobites and other fossil organisms; and all arise from ignorance of the facts in the several cases.

First, and this applies especially to the trilobites, we know too little of the complete animal and can not entirely overcome the resulting doubt as to the original association of the dismembered parts that we bring together in describing our species and genera. Such features as the number and character of the thoracic segements, the free cheeks, eyes, doublure, epistoma, hypostoma, legs and other features of the ventral side, all of which are important factors in our inquiry, often remain entirely unknown.

Second, the available links in the lines of descent usually are too far apart.

Third, we often forget entirely or at least do not give adequate consideration to the fact that the geological record is far from complete, and thus we fail to appreciate the greatness of the break between certain systems. The effect of this lack of appreciation is particularly great in estimating the probable and possible changes that occurred during the exceedingly long time that separates the close of the Upper Cambrian and the beginning of the Ordovician, as these periods are now restricted and defined. An idea of its length is gained when we consider that two great systems of deposits, each fully equal in duration and possibly organic modification to either the Silurian or the Devonian system, are being slowly worked out and faunally characterized. Only a few years ago we knew practically nothing of the intervening Ozarkian and Canadian periods. And even now we are only beginning to realize what and how much happened during their terms in the way of modifying—in almost haphazard fashion—the ever-changing stream of life.

Fourth, since it has been established that the fossil marine faunas of deposits in continental basins invaded the latter, when occasion offered, from one or another of the oceanic realms in which their respective and characteristically different biota lived and accomplished the specific and generic changes observed in comparing the fossil faunas now accessible, the need of determining the originating source of the fossil remains has become no less essential in systematic investigations than in the age correlation of the beds containing them. Obviously, these determinations involve exceedingly complicated problems whose solution requires abundant and good material and much time. Progress is slow and usually not fast enough to keep abreast of new acquisitions.

To these four deterring conditions I might add another. This is the difficulty of correcting previous faulty or definitely erroneous determinations and plausible suggestions that have now become ingrained in the fabric of our text-books and literature in general. Most of these erroneous conceptions are occasioned by the usually laudable but incautiously exercised desire of zoölogists to bring into orderly arrangement the chaotic mass of inadequately studied fragmentary material on which, if we are to make any progress at all, we are obliged to found our descriptions of species and genera. In fact, though referring especially to the trilobites, we know so little about the subject in

general and about the genetic relations of the generic groups in particular that all preceding and any present effort to classify them into families and groups of higher rank can be nothing better than a provisonal arrangement. The paramount need of the present is to work out the facts.

PALEONTOLOGY.—Trachelocrinus, *a new genus of Upper Cambrian crinoids.*[1] E. O. ULRICH, U. S. Geological Survey.

Cambrian crinoids at all well preserved are extremely rare and desirable. They are particularly needed in these days when prevailing classifications are in course of modification along lines in which the genesis of the animals is being given greater consideration than heretofore.

The specimen that is the subject of this communication was collected by Dr. C. E. Resser and Mr. Robert Bassler from the upper part of the Gallatin limestone just above Hayden Falls, Republic Creek, a mile south of Cooke City, Montana. The particular bed in which the specimen was found is correlated with the "crinoid zone" of the Franconia formation in the upper Mississippi Valley where it lies between the top of the Ironton sandstone member and, as in the Montana section of the Gallatin, just under the widely distributed *Eoorthis* zone.

Though an unquestionable crinoid, it is exceedingly difficult to find a satisfactory resting place for this unique Cambrian fossil in any of the several classifications now in common use. It can hardly be referred to the Eocrinoidea: the stem is too well developed and the arms have a type of branching or pinnulation and a plate-covered ambulacral furrow, neither of which conditions is known to occur in that subclass. This crinoid is definitely of a higher order. Probably Jaekel's subclass Cladocrinoidea includes its nearest relatives, and it may be viewed as an early stage in the evolution of those crinoids. But none of the numerous cladocrinoid genera and families adopted or instituted by Jaekel can justly include our new crinoid. It must stand for the present as the type of both a new genus and a new family which we may provisionally place in the Order Dicyclica. This opinion is expressed despite the fact that considerable resemblance, at least in general aspect and structure, is notable on comparison with a large but as yet unpublished group of cystids that we have found in the Chazyan rocks of east Tennessee.

[1] Received January 3, 1929. Published by permission of the Director of the U. S. Geological Survey.

The arms are five in number, long and moderately stout, the brachioles arranged in a double series, each somewhat longer than wide, the fourth and eighth, and then each succeeding third or fourth on the left side of the arm, bearing a short biserial armlet approximately half as wide as the main arm. In the two arms that exhibit their bases the first brachial on the right side gives off a short armlet like those on

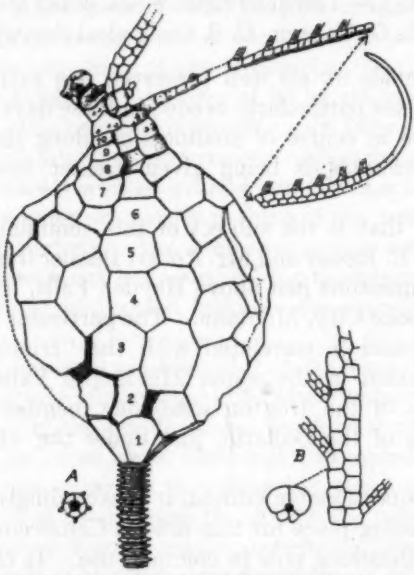

Figure 1.—Outline drawing, × 1.7, of the left side of the nearly entire but crushed specimen upon which the new genus and species *Trachelocrinus resseri* are based. The outline of the calyx, as it lies on the bedding plane of the slab of shaly limestone, is approximately normal, but the form and arrangement of the plates, the ranges of which are numbered 1 to 10 in the figure, was more or less disturbed under the weight of the sediments that reduced the opposite dimensions of the bottle-shaped calyx to less than one-fourth of its original diameter. Accordingly, most of the plates in the middle part of the drawing were originally wider. A, cross-section of column. B, lower part of arm showing its biserial character, the single pinnule or armlet on the right side, two of the armlets that occur on each succeeding third or rarely fourth brachiole of the left side, and a cross-section of the arm.

the left side of the arm. The ambulacral furrow on both the main arm and its short branches is narrow and covered with two alternating and relatively thick series of plates.

The column, of which about 2 inches is preserved, is round and in the proximal inch consists of alternating very thin and thicker 5-partite columnals, the sutures between them minutely crenulated on the surface. Each of the larger set carries, presumably, 5 spines.

The lumen is cylindrical and, excluding the outer spines, takes up about half of the diameter of the column. In the distal third of the

Figure 2.—*Trachelocrinus resseri* Ulrich, n. gen. and sp., nat. size and × 2

2 inches of column preserved the two sets of columnals are nearly equal in thickness.

Trachelocrinus resseri Ulrich, n. gen. and sp.

An apparently normally long-stemmed pentamerid crinoid, with subovate, urn or bottle-shaped body contracted above to form a relatively narrow neck-like support for the long arms. Neck trilobed in cross-section. Calyx, with numerous plates, arranged in irregularly alternating transverse ranges, most of those in the middle ranges hexagonal, the basal range five in number and pentagonal; the second, six and mainly hexagonal; the third, fourth, and fifth ranges more or less irregularly hexagonal and varying in number from nine to eleven; the sixth range heptagonal and probably nine in number; the seventh range—making base of neck—small, ten in number, five of them pentagonal, five smaller and quadrangular; the eighth, ninth and tenth ranges also ten each, small, much wider than high, and arranged in longitudinal series with the plates of the seventh and sixth ranges; the tenth range only five in number, as low as those under them but twice as wide and with the sutures between them falling over the middle of each second plate of the preceding four ranges. Finally, the arms are set directly over the sutures of the terminal neck range.

The excess in number above five and the irregularities in shape of plates in the third, fourth, and fifth ranges, which span the most inflated part of the calyx, is due to the intercalation of similar plates that in such more normally plated crinoids as the Cladocrinoidea would be called interradials. Indeed, the right half of the side exposed in the specimen suggests a larger "interradial" area that would correspond to the anal interradius. That this suggested orientation may well be correct is further indicated by the fact that whereas four of the arm bases are close to each other the fifth, which should be the anterior, lies farther from its neighbors and directly opposite the supposed anal interradius.

Basals five, high, pentagonal; above them six alternating ranges of plates, all but those of the last two ranges somewhat irregularly hexagonal. In the sixth range, beginning with the basals, the plates are heptagonal, the middle of the upper edge of each being truncated to support one of the series of small quadrangular plates which separate the sides of the larger pentagonal plates that make up the greater part of the seventh range. So far as can be seen, each of the ten plates of the seventh range is succeeded by a series of three short plates (at least twice as wide as long). These are succeeded by the final range which consists apparently of but five plates that carry nodes and are not longer but wider than the preceding ten-plate ranges. Finally the biserial arms rest on the sutures of the five-plate range.

ARCHAEOLOGY.—*On the recent finding of another flint arrow-head in the Pleistocene deposit at Frederick, Oklahoma.*[1] CHARLES N. GOULD, Director, Oklahoma Geological Survey. (Communicated by O. P. Hay.)

The Frederick gravel bed in which, during the past two years, a number of bones of prehistoric animals and several human artifacts have been found, is located on a ridge a mile north of the town of Frederick, county seat of Tillman County, southwestern Oklahoma.

[1] Received January 3, 1929.

The greater part of the surface of Tillman County consists of red clays and shales of Permian age. These shales have been eroded and dissected by streams flowing south, but, in general, the relief of the plains will not exceed 50 to 75 feet. The ridge upon which the gravel bed is located stands 80 to 100 feet above the surrounding plain, averages a half mile wide, and extends north of Frederick a distance of eight to ten miles, where it merges with the level uplands.

The gravel bed which caps this ridge is composed of typical cross-bedded stream gravel, such as occurs in many parts of Oklahoma and adjacent states, being made up of rounded and sub-angular, water-worn pebbles, varying in size from fine sand grains up to those four and six inches in diameter. The great majority of the pebbles, however, are small, being less than one inch in diameter. The material is largely igneous rock, such as granite, diorite, and the like, which make up the great mass of the Wichita Mountains some twenty to thirty miles to the north. Most geologists who have visted the region believe that the greater part of the material came originally from the mountains. The gravel varies in thickness in different parts of the ridge from a few feet up to something like twenty feet. At the pit where the bones and artifacts have been found, the upper 3 to 5 feet is composed of soil, beneath which there is a gradation from soil to the undisturbed gravel. The gravel itself is here ten to fifteen feet thick. Near the bottom of the quarry, and just above the top of the red beds upon which the gravel beds rest, there is a zone of indurated or hardened material, probably caused by the water percolating through the loose gravel until its flow has been checked by the impervious red clays beneath.

Geologists who have studied the problem believe that the gravel beds now on the top of the hill north of Frederick represent an old river channel which, during Pleistocene times, found its way from the Wichita Mountains southward toward the present site of Red River. If this is true, the ridge which is now 100 feet above the surrounding plains must have been a valley. While there is no means of knowing how high the hills stood on either side of this valley at the time when the gravel beds were laid down, it is reasonable to suppose that the general level of the region was at least 50 to 100 feet above the present gravel beds. If this is true, the general region must have been eroded as much as 150 feet.

According to Mr. A. H. Holloman, the owner of the gravel pit, the bones, metates, and arrowheads have been found scattered here and there throughout the lower half of the gravel. The first scientists to

examine this gravel pit were Messrs. J. D. Figgins and Harold Cook, of the Denver Museum, who visited the quarry in January, 1927, and took away with them the metates, arrowheads, and many of the bones. These articles are now in the Denver Museum. Since that time a number of scientific men have examined the deposits, including Dr. Oliver P. Hay, of Washington, D. C.; Professor Albert Jenks of the University of Minnesota; Professors C. E. Decker, Leslie Spier, A. O. Weese, A. I. Ortenberger, and the writer from the University of Oklahoma. So far as I am aware, all of the scientific men who have visited the gravel bed are in accord as to the facts as stated above.

The point at issue seems to have been as to the actual finding of the bones and artifacts in the undisturbed gravel, and the possibility that these materials might have worked their way down through crevices from the surface. The bones and artifacts have all been found by the owner of the pit, Mr. Holloman, during the course of his excavations in the quarry, and no scientist, so far as I am aware, has seen these objects *in situ*.

About September 19, 1928, Mr. Holloman found an arrowhead in place in the undisturbed, cross-bedded gravel, 13 feet below the surface, and Mr. A. H. Krause of Frederick, a long-time friend of the writer, went immediately to the quarry and took several photographs of this arrowhead before it had been removed from the matrix These photographs were sent to Norman, and on October 5, Professors Spier, Weese, Ortenberger, and myself, all from the State University of Oklahoma, drove to Frederick and spent October 6 in the pit. We took additional photographs of the place from which the arrowhead had been secured. There is no doubt in my mind that the gravel where the arrowhead was found had been undisturbed since the time of its deposition in Pleistocene times, and there appears to be no possibility that the arrowhead could have found its way downward along crevices from the surface.

I know of no criteria other than that of fossils which would give a clue to the time which has elapsed since this river gravel was laid down. Probably Mr. Harold Cook's estimate of 365,000 years, as recorded in Scientific American for August, 1927, is as nearly accurate as any estimate that may be made.

BOTANY.—*A new* Maurandya *from Arizona.*[1] FRANCIS W. PENNELL, Academy of Natural Sciences, Philadelphia, Pa. (Communicated by T. H. Kearney.)

In the spring of 1928 Mr. Robert H. Peebles discovered an unfamiliar plant growing on rocky ledges in the canyon of Fish Creek, a tributary of Salt River, at the eastern extremity of Maricopa County, south-central Arizona. After a vain effort to identify it among the specimens of *Maurandya* in the United States National Herbarium, Dr. T. H. Kearney, of the U. S. Department of Agriculture, who was with Mr. Peebles when the plant was gathered in flower on April 1, forwarded flowering and fruiting material to me with the suggestion that I should describe the species, if it prove new to science.

Inspection of the two collections at hand has shown Dr. Kearney to be fully justified in suspecting that this is an undescribed species of *Maurandya*. It must look very different in the field from any other species of this genus in the United States. Forming short thick tufts with stems scarcely or not twining, with leaves that are widely cordate and less cleft or jagged, and with yellow rather than purple corollas, the plant is but distantly akin to these. Its only close relationship is with the recently discribed *M. flaviflora* Johnston[2] of Lower California; together they constitute a natural section of *Maurandya*, but the following contrast shows that between them there are many distinctions:

Stems slender; leaf-blades shallowly dentate, the teeth again serrate; fruiting pedicels curving until contorted; corolla 25–28 mm. long, the posterior lobes longer and arched; stamens exserted; seeds 2 mm. long. *M. flaviflora*

Stems stout, thick; leaf-blades palmately lobed, the lobes entire; fruiting pedicels merely recurved; corolla 20–22 mm. long, the lobes all uniform and spreading; stamens included; seeds 1–1.5 mm. long. *M. acerifolia*

Maurandya acerifolia Pennell, sp. nov.

Perennial, forming loose mat-like growths; glandular-villous throughout. Stems becoming thick, much branched, white-villous below. Leaf-blades mostly 1.5 cm. long, 2.5 cm. wide, broadly cordate or reniform, obtuse, with about 7 broadly triangular, sharp or rounded lobes; petioles slender, straight, 1.5–2 cm. long. Pedicels slender, in anthesis 10–20 mm. long, in fruit becoming thicker and recurved. Sepals in anthesis 6 mm. long, triangular-ovate, in fruit slightly accrescent. Corolla 20–22 mm. long, pale yellow, cylindric, two-ridged within anteriorly but lacking a palate, externally nearly glabrous, internally finely pubescent on all sides at base and over bases of filaments, distally glabrous except for the two anterior ridges, these

[1] Received December 31, 1928.

[2] Proc. Calif. Acad. Sci. IV. 12: 1162. 1924.

densely pubescent with flat yellow hairs; lobes uniformly spreading, all ovate-orbicular, 4–5 mm. long. Stamens included, didynamous; filaments finely pubescent near base, distally glabrous or with a few tack-shaped glands; anthers 1–1.2 mm. wide, the cells circular. Style slender, glabrous. Capsule globose, 8 mm. long, each cell opening loculicidally by distal ruptures, the septum and adjacent capsule-walls persisting, the placentae evident as central aggregations of short knobs. Seeds 1–1.5 mm. long, gray or blackish, with corky longitudinal ridges.

Type in the United States National Herbarium, collected in rock crevices, Fish Creek Canyon, eastern Maricopa County, Arizona, in flower, April 1, 1928, by R. H. Peebles, G. J. Harrison and T. H. Kearney (no. 5246). Also gathered in fruit at the same locality, April 22, *Peebles & Harrison* 5286. Dr. Kearney informs me that the locality is "in the canyon of Fish Creek about one mile above the confluence of that stream with Salt River, and a few miles below the Roosevelt Dam."

The specific name *acerifolia* has been chosen because the leaf-blades suggest those of maple, the palmate lobes being prominent, although the intervening sinuses rarely extend a third of the distance from the tips of the lobes to the base of the blade.

BOTANY.—*Plants of Lower Californian relationship in central Arizona.*[1]

THOMAS H. KEARNEY, Bureau of Plant Industry.

In the preceding article, Doctor Pennell describes a new species of the Scrophulariaceae (*Maurandya acerifolia*) from Fish Creek Canyon, near the center of Arizona, and points out that its nearest relative is *M. flaviflora* Johnston, a species known only from Las Animas Bay, on the eastern coast of Lower California nearly half-way down the peninsula. The fact is noteworthy in view of the occurrence in and near Fish Creek Canyon of a shrub belonging to the Rhamnaceae, *Colubrina californica* I. M. Johnston,[2] which is not known to occur elsewhere than at Las Animas Bay and another locality near the middle of Lower California.

The occurrence in this part of Arizona of two plants of widely different botanical relationship, one apparently identical with and the other closely related to a species inhabiting Lower California, constitutes a puzzling problem in geographical distribution. Neither the *Maurandya* nor the *Colubrina* have fruits and seeds that appear to be adapted to dissemination by birds. One can only guess at an explanation of the occurrence of this minute "islet" of plants of Lower California affinity so many hundred miles to the northeast, in the interior of Arizona. Assuming that the same forms, or nearly related

[1] Received December 31, 1928.

[2] Proc. Calif. Acad. Sci. IV. **12**: 1085. 1924. Dr. Johnston has confirmed the identification of the Arizona specimens of this *Colubrina* and states that they differ from the Lower Californian plant only in the size of the fruits.

ones, are absent in the intervening territory, an explanation of this anomalous distribution must be sought in the geologic history of the region.

The climate and topography of the Arizona–Sonora–Lower California region doubtless have changed considerably during or since the Tertiary. It is believed that in Pliocene or Pleistocene time, the Gulf of California extended considerably farther north, and perhaps northeast, than at present. Ross[3] has suggested that the calcareous beds of the lower valley of the Gila River may "mark the northern limit of this incursion of marine waters."

Perhaps these species of *Colubrina* and *Maurandya* are relics of a flora once continuously distributed around the shores of the ancient gulf, the remains of which have become separated by increasing aridity in northwestern Sonora and southwestern Arizona. The recent discovery, in Yuma County, Arizona, of a palm of the genus *Washingtonia* (*W. arizonica* Cook) nearly related to the fan palm of the western side of the Colorado Desert (*W. filifera Wendl.*) may be regarded as additional evidence of rather profound changes in the climate and topography of this region.

SCIENTIFIC NOTES AND NEWS

NATHAN W. BASS has resigned as geologist with the U. S. Geological Survey to accept a position on the staff of the Pure Oil Company with headquarters at Tulsa, Oklahoma.

CHARLES E. ERDMANN has been transferred from the Geologic Branch of the U. S. Geogical Survey to the Conservation Branch and assigned to the Denver office.

Dr. WILLIAM BOWIE, Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, has recently been elected a corresponding member of the Academy of Sciences of the Institute of France.

Mr. H. W. V. WILLEMS of Delft, Holland, has been spending some months in the Chemical Laboratory of the Geological Survey studying methods of analyzing rocks. After some time in the Geophysical Laboratory Mr. Willems expects to spend five years in Java in connection with geological and petrographic investigations in the Dutch East Indies.

The Department of Geology of the United States National Museum has recently added to its collections a large platinum nugget, associated with chromite and weighing over 17 troy ounces, from the Chocoya River, Colombia. A large section of a pegmatite from Newry, Maine, showing large "watermelon" tourmaline has also been acquired. An unusually fine cut blue topaz from Maine has been added to the gem collection.

[3] CLYDE P. ROSS. *The Lower Gila region, Arizona.* U. S. Geol. Surv. Water Supply Paper 498: 31. 1923.

Obituary

Dr. JOSEPH GOLDBERGER, Director of Field Studies in Nutrition, U. S. Public Health Service, and a member of the ACADEMY, died January 17 in Washington from an undetermined disease contracted during the course of his work. Dr. Goldberger was born July 16, 1874, in Austria-Hungary, received the degree of Doctor of Medicine from New York University in 1895, and entered the Public Health Service in 1899, becoming Director of Field Studies in Nutrition in 1914. He contributed materially to the study of several epidemic diseases, but was best known for his investigations into the cause and treatment of pellagra.

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